ADDENDUM

To

Proceedings of Symposium

Project VELA

20 July 1961

ADVANCED RESEARCH PROJECTS AGENCY

20 July 1961

# PREFACE

This publication is an addendum to the Proceedings of the Project VELA Symposium, held at the Pentagon in October 1960. The two papers comprising this addendum were originally presented in classified versions at the Symposium; those versions were reviewed and rewritten to enable their present distribution in unclassified form. A distribution list is also included.

# DASA'S RESPONSIBILITY AND ORGANIZATION FOR TESTING

by

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Defense Atomic Support Agency

# DASA'S RESPONSIBILITY AND ORGANIZATION FOR TESTING

P. G. Galentine

As most of you may know, DASA, or AFSWP as it was known prior to May 1959, has been in the Atomic Testing business since World War II. Based on the operational requirements for information we establish the technical requirements for experiments. Project proposals are then submitted to us by the various research organizations for review and approval. DASA, Field Command at Albuquerque, determines the support required and then programs the support to the project. Then, they organize all the DOD experimenting groups into the DOD Technical Testing Organization, headed by the Field Command Test Group.

When tests are being conducted at the EPG this DOD Technical Testing Organization becomes a Task Unit of the Joint Testing Force which supports them and creates the testing environment required for the various experimental projects.

When tests are being conducted at the NTS this DOD Technical Testing Organization becomes a part of the AEC's NTSO along with various other users and receives the technical and logistic support required for the various experiments.

Field Command provides the Military Deputy Test Manager and a support organization as part of the NTSO. This support organization provides the military support required by, not only the DOD User Group, but also to the various other users.

After the tests are completed the test data collected flows back to DASA for quality control and publication. After being analyzed it is prepared in selected forms and disseminated to users.

Because of DASA's organization and experience in the testing business and its assigned mission to supervise all DOD atomic test activities, the Advanced Research Projects Agency asked DASA to assume in its behalf responsibility for the proposed VELA-UNIFORM explosion series which includes coordination with the AEC for all nuclear and HE shots at the NTS and for nuclear shots outside the NTS. The coordination and teaming up with the AEC are necessary because they are responsible for funding and accomplishing all HE shots fired at the NTS and for all the nuclear shots of the VELA-UNIFORM series without regard to location. The AEC will also make some close-in measurements and determine the yield for all nuclear shots.

In addition to the responsibilities that I have already mentioned, DASA will conduct the large HE shots outside the NTS and will coordinate and control all DOD activities at shot sites. The Air Force Technical Applications Center will formulate the over-all technical requirements of the measurement program to which DASA will be responsive.

The DASA and DASA Field Command are proceeding with this assignment much in the same manner as they would for a regular nuclear weapons effects test series.

An organizational structure has been jointly developed by Field Command and ALO/AEC for implementation of the various parts of the explosion series. For simplification I will eliminate some of the detail and show you a condensed version in order to emphasize the major parts. (See Figures 1 and 2.)

For purposes of clarifying lines of authority and responsibility for joint planning in areas of common interest and field operations, AEC/ALO and FC/DASA have agreed in the assignment of Mr. James Reeves, AEC/ALO, as Project Manager and Colonel Leo A. Kiley, FC/DASA, as Associate Project Manager for the shots at the NTS (CONCERTO) and the nuclear shots in other sites within the United States (DRIBBLE).

In these capacities they will be individually responsible for the AEC and DOD participation but equally responsible for determining site locations and deciding when shots will be detonated.

It is believed that this joint team is a fine arrangement for accomplishing this task.

For the measurement program under the cognizance of DASA, the technical requirements come (Figure 3) from AFTAC to DASA by way of ARPA. DASA develops this further and gives more detailed guidance to the project agencies upon which they develop project proposals and (Figure 4) send them back to DASA. Field Command in coordination with AEC/ALO determines the support requirements of the proposal for DASA which then incorporates them into a technical and support plan and takes it to AFTAC for coordination and then on to ARPA for approval.

After the plan is approved it is (Figure 5) sent back to DASA Field Command with money. Field Command then programs money and support to the project and binds it, along with other projects, into the DOD technical testing organization which then plugs into the NTSO and operates as a part of it. After the various shots are conducted, the data collected will flow back in a manner yet to be prescribed through DASA and AFTAC to ARPA and the users.

In response to a memorandum from the Office of the Assistant Secretary of Defense for Public Affairs, DASA has prepared and is now implementing a broad public affairs plan to support that of VELA-UNIFORM concerned with the underground chemical and nuclear explosion series and the construction of prototype detection stations.

It may be well to point out that many portions of this test program are dependent on the outcome of the earlier portions. A great deal of the planning for the leter shots is likewise dependent on the outcome of the earlier shots.

In conclusion, it must be emphasized that the nuclear test explosions discussed above have not been authorized to date.

# NTS ORGANIZATION

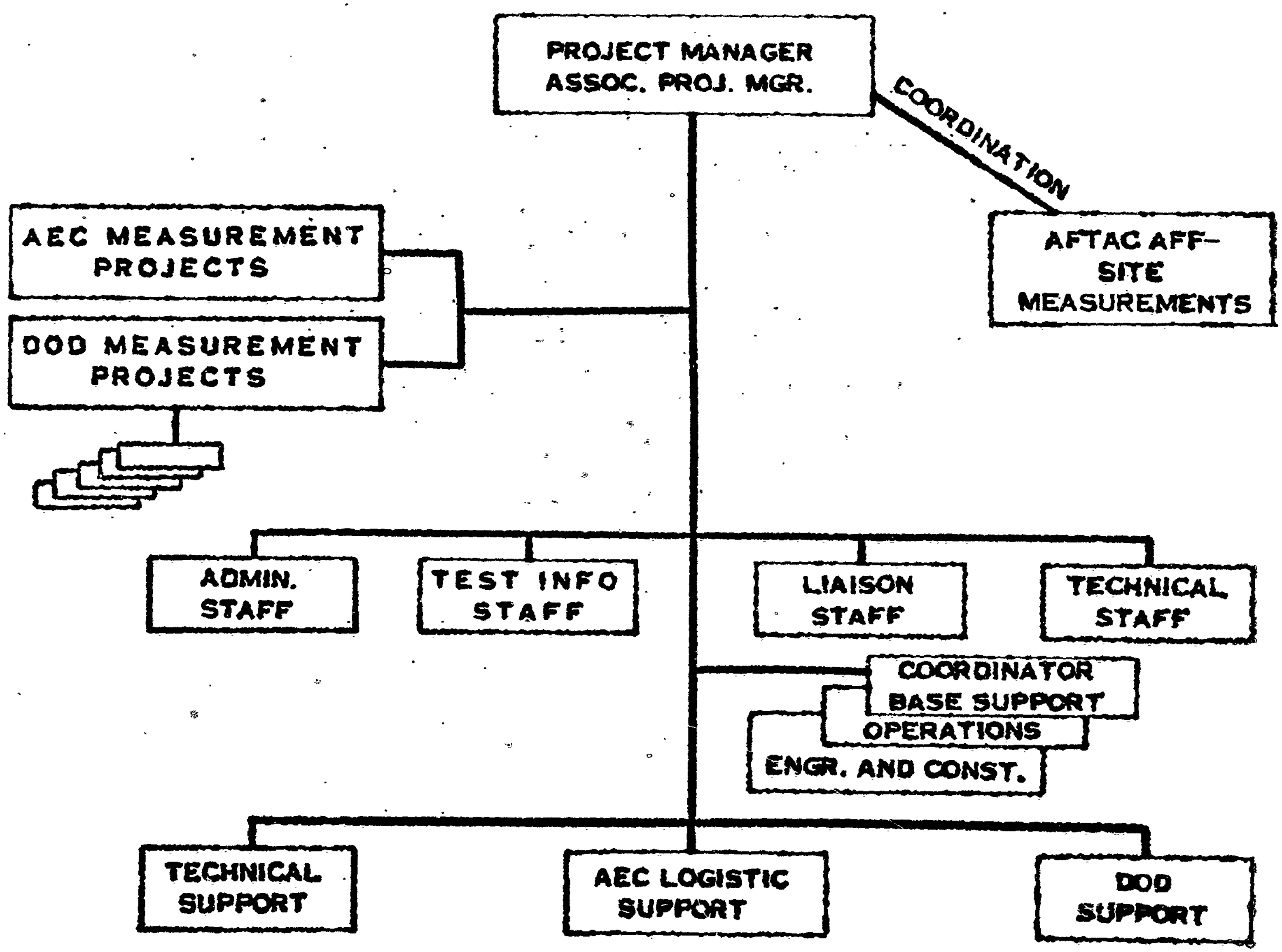


Figure 1

# ORGANIZATION FOR DRIBBLE

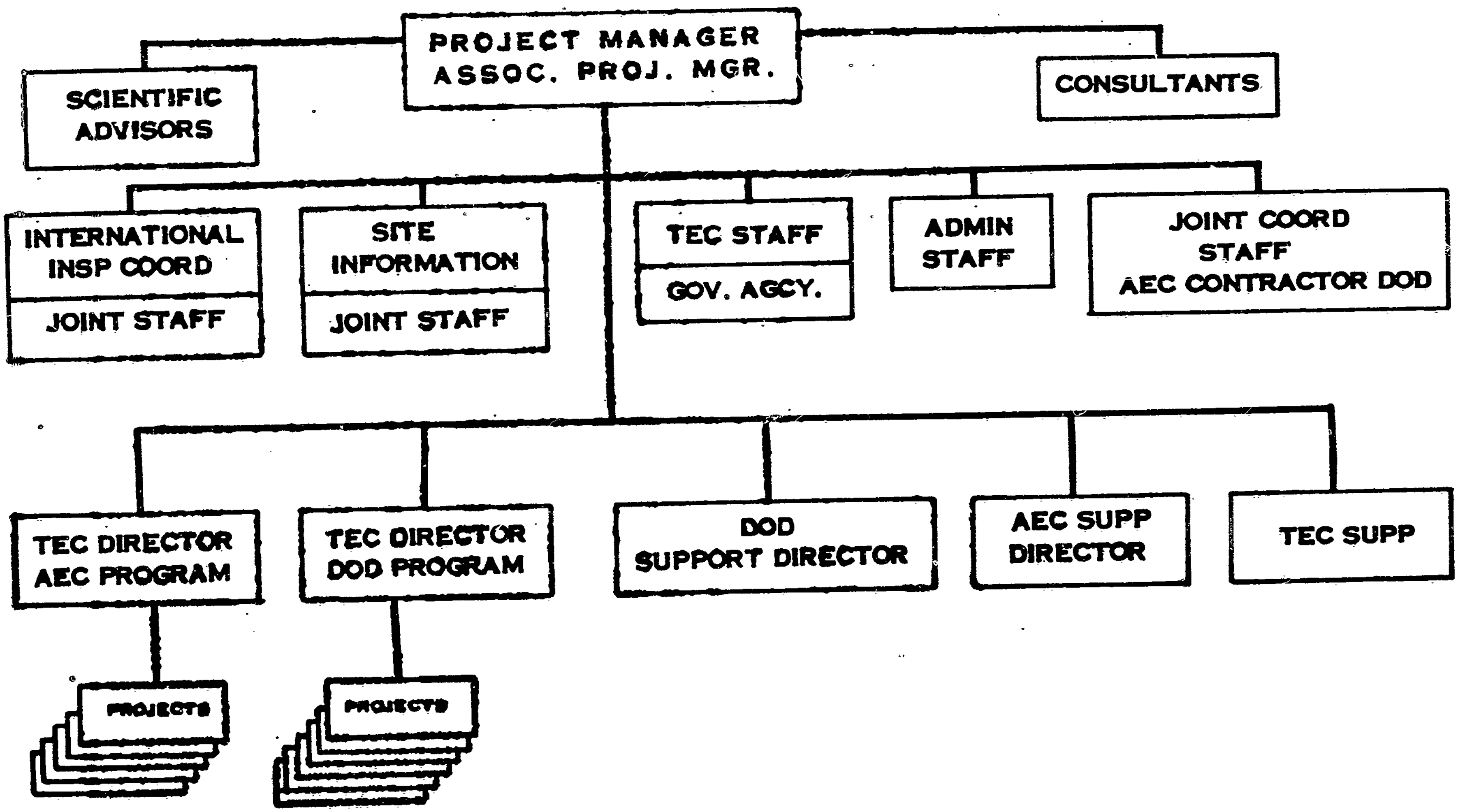


Figure 2

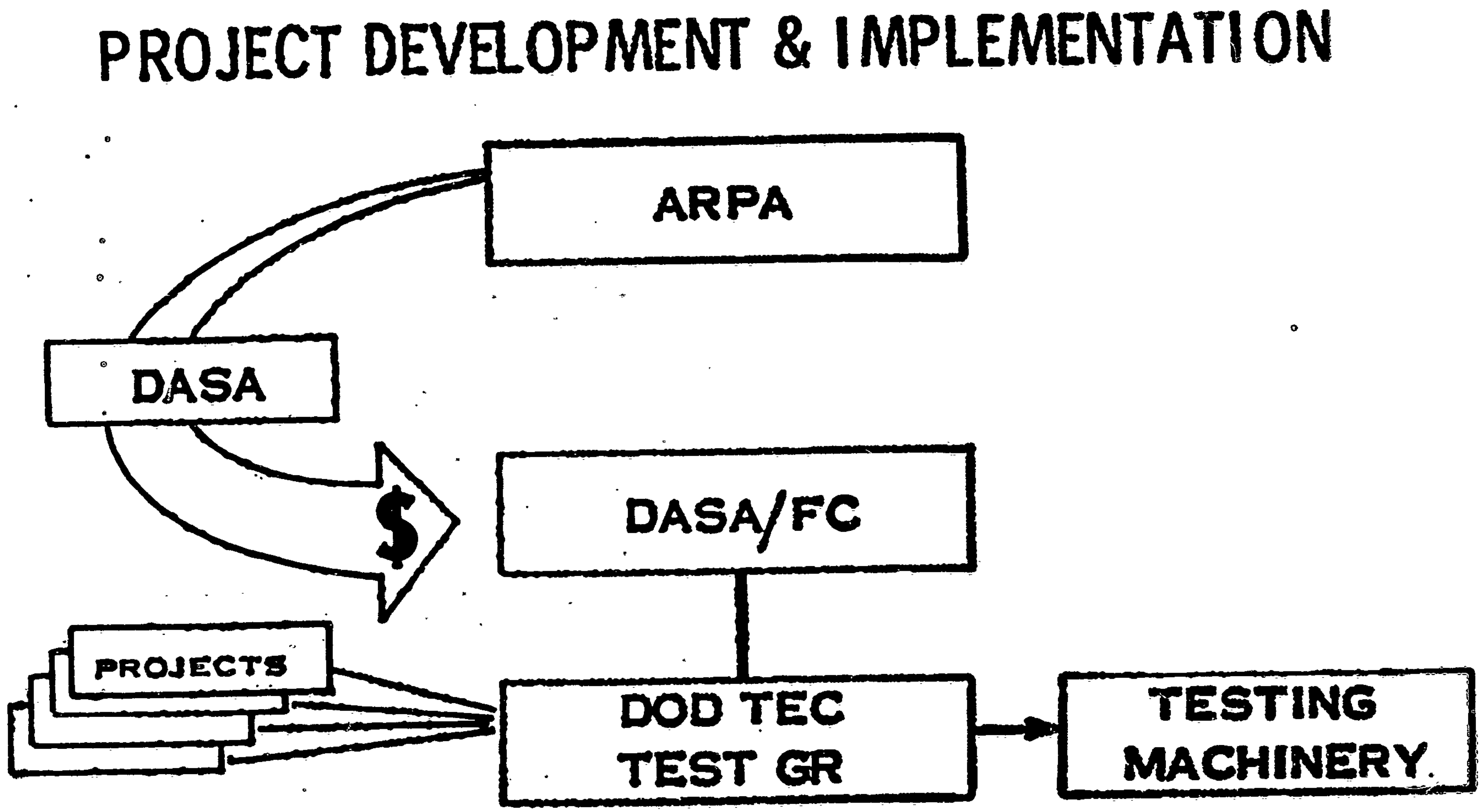
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Figure 3

# TECHNICAL REQUIREMENTS

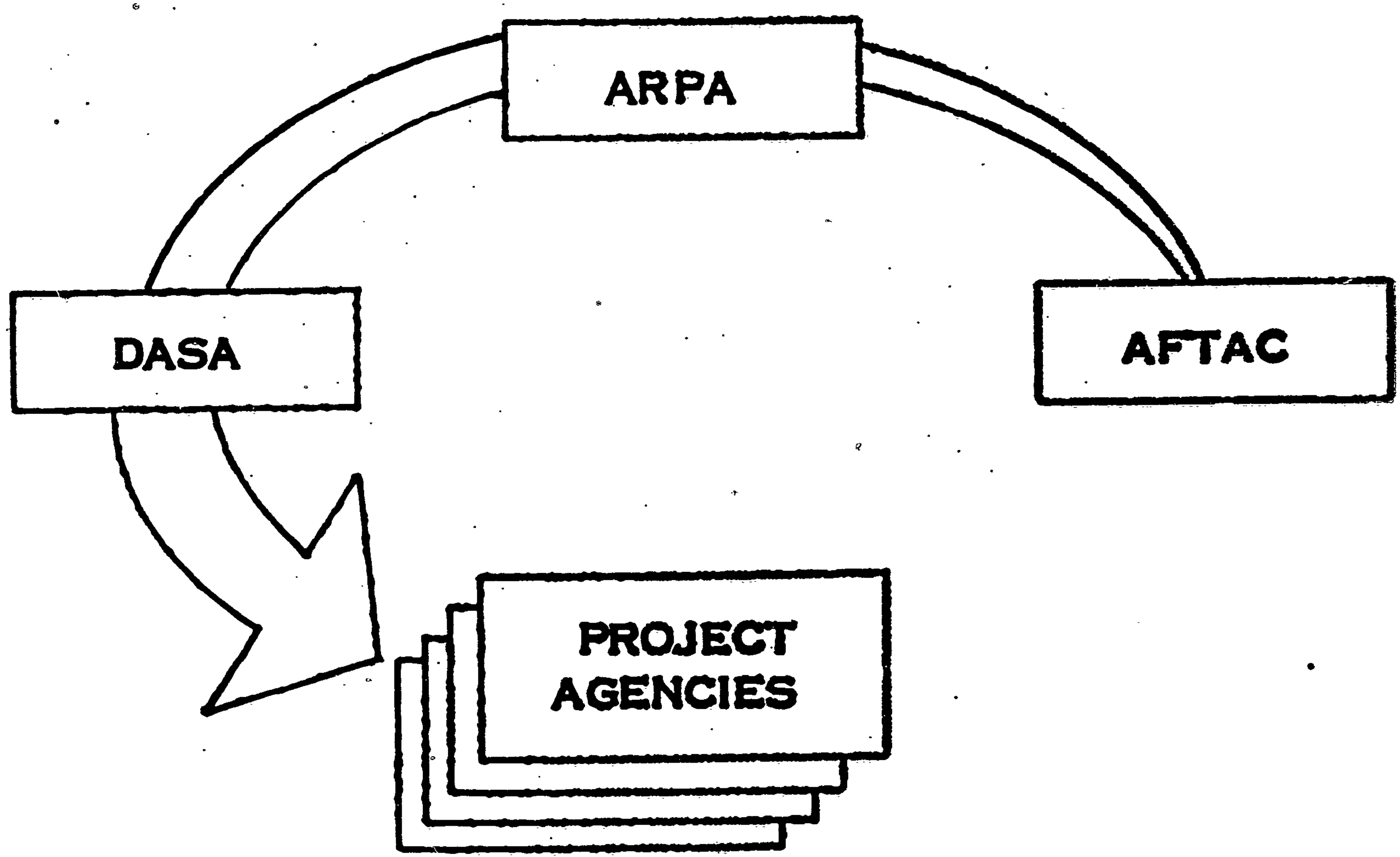


Figure 4

# PROJECT PROPOSALS

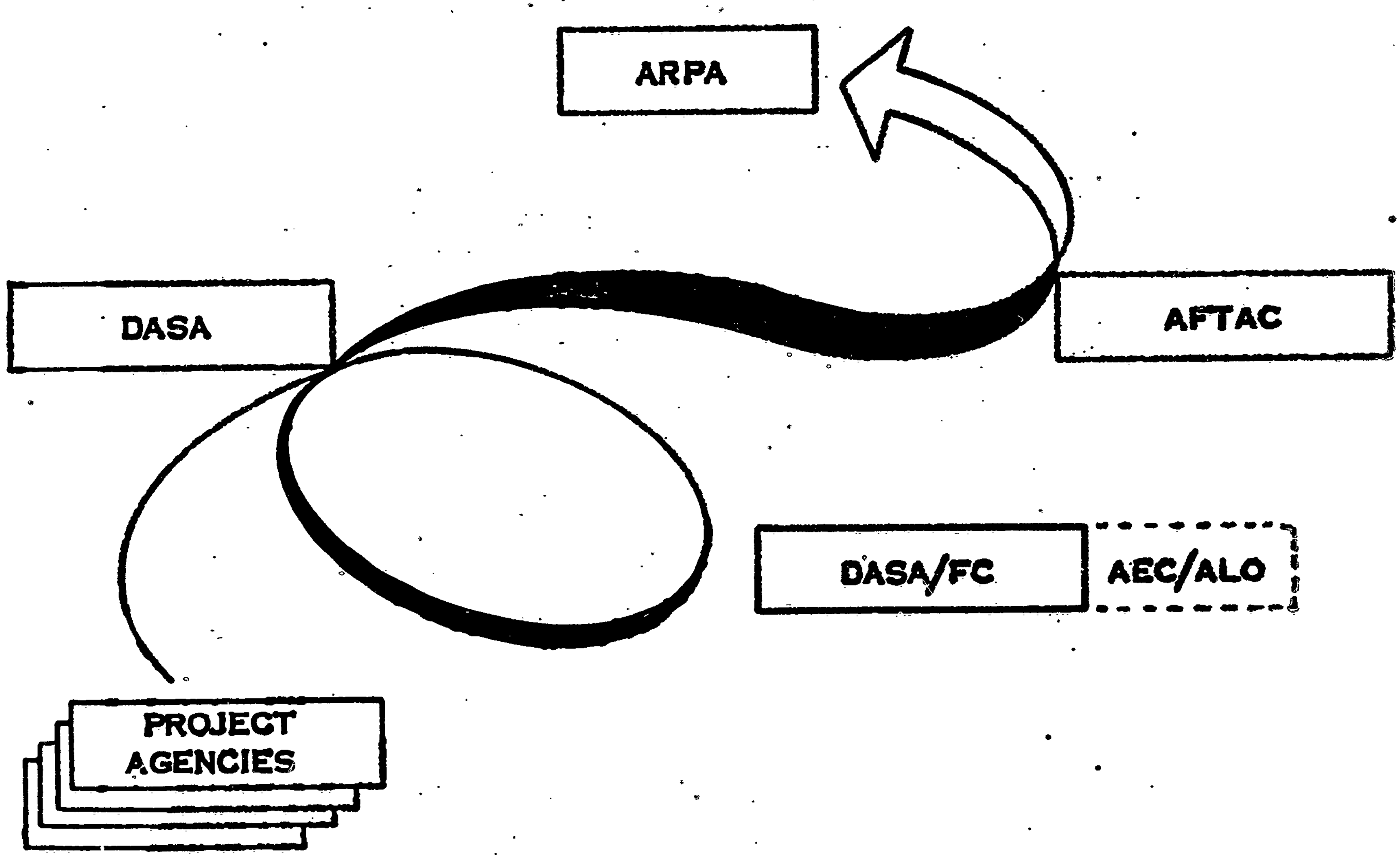


Figure 5

# THE PROBLEM OF ON-SITE EXPLOSION INSPECTION

by

Mr. Robert Scheid
Air Force Technical Applications Center

# THE PROBLEM OF ON-SITE EXPLOSION INSPECTION

Robert Scheid

In discussing the methods and problems of on-site inspection, I should like to cover first the types of events that can be inspected; that is, the criteria that have been set up for inspection; second, the locations most suitable for clandestine testing; third, the general characteristics of clandestine nuclear tests, in particular those characteristics that are of significance to inspection; fourth, the methods and techniques an inspection may use; and fifth, the research program as we now see it.

The problem facing on-site inspection is to determine the nature and, of course, the exact location of seismic events that have been detected by the control system and that are suspected of being clandestine underground nuclear tests. Before such an inspection can be undertaken, however, the event in question must meet certain criteria which are outlined here on my first slide (Fig. 1). First, it must be at least magnitude 4.75 (that is, about 20 KT). Second, it must be recorded at a sufficient number of control posts in the detection system to establish the approximate time and place of its occurrence. Specifically, at least four arrival times must be recorded at three different control posts to establish time and position of the event.

Specifically exempted are events whose depth of focus is established as being below 60 kilometers, events that can be established as either foreshocks or aftershocks of earthquakes of at least magnitude 6, and events whose epicenters are located in the deep ocean but for which no consistent hydroacoustic signals are received.

Assuming that an event meets these broad criteria and is selected for inspection under the quota system, the size of the geographic area that can be inspected will, according to the present U. S. position, vary from 200 to 500 square kilometers or from approximately 75 to 200 square miles. This variation is based on the number of control posts around the epicenter of the event. If control posts are located in every possible 90° sector, the area will be limited to 200 square kilometers. If control posts are located on only 2 or 3 sides, the area will be 500 square kilometers.

Imagine, then, that the control system dispatches an inspection team to a site. We hope they can arrive within about 1 week after the event. What should they look for? (Fig. 2) We have listed here some of those characteristics of a clandestine nuclear test that are of significance to on-site inspection. Though an attempt undoubtedly would be made by a violator to cover up or eliminate many of these characteristics, there probably would still be evidence that was overlooked by the violator or impossible to hide.

First, the test would require some preparation of the site, which in turn would involve a work party and associated vehicles and equipment. Depending on the nature of the test, it is estimated that on-site activity could persist for a pre-test period of a month to more than a year followed by 3 to 4 days for clean-up after the shot. The work party would probably need tunneling or drilling equipment to reach the shot point. Certainly, some means must be found to dispose of mine rubble or drilling mud. Pre-shot preparations also may require new road or airfield construction, or mooring facilities for ships if an offshore test were conducted.

Presumably, the justification for clandestine nuclear tests would be knowledge obtained from such instrumentation as might be installed. This could be a minimum amount of instrumentation designed simply to give yield and reaction history; even in this minimum case, however, personnel would be needed for installation, servicing, and data recording. Perhaps some 10 to 12 men on site for 3 to 4 days could install the device, instrument it, record data, and clean up after the firing. If more elaborate instrumentation were used, instrument holes would have to be drilled, and additional cable or telemetering equipment would have to be installed and moved out.

The firing of the device will leave certain effects in the environment. Underground, a rubble-filled cavity would be formed that would approximate 70,000 cubic yards per KT. Possibly, depending on the geology, a chimney from this cavity toward the surface would also be formed. The shockwave might cause root damage to vegetation immediately above and around the surface zero. If the shot were not adequately buried, there could be venting, fracturing, and faulting in the surrounding area.

These test characteristics and effects suggest various inspection methods which are listed on the next figure. The main problem facing an inspection team at this initial stage of its activity is that of reducing the area from one of several hundred square kilometers to one of more manageable size--that is, to a smaller area where geophysical techniques can be employed more effectively. Thus, in the first phase of the inspection, attempts would be made by means of aerial photography, including black and white, color, camouflage detection, and infra-red, to pick up clues such as roads, unusual human activity, vegetation damage, and mine openings that would enable the team to rapidly concentrate its efforts in one or a few small areas. In addition, seismic noise monitoring using strings of geophones might be employed to locate the epicentral area. In the smaller areas geophysical techniques might be employed such as seismic profiling in order to detect the crushed zone or cavity from the explosion. Magnetic and electromagnetic surveys might be flown in order to detect drill hole casings or other metallic objects. In the case of a marine environment, acoustical surveys could be made to determine bottom modification or crushed zones. Surface subsidence measurements might be conducted in order to detect continuing vertical motion of the earth's surface resulting from the formation of a cavity or chimney. If these or other techniques successfully point to shot location, it is then possible to drill into the crushed zone or cavity in order to obtain fission product evidence.

This, in brief outline, is the anticipated procedure.

The general goal of the on-site inspection research program is to develop operational techniques for an inspection team to use in determining the nature and location of a seismic event. Specifically, we must

(1) adapt and improve techniques that have already proved useful in other fields;

(2) seek out and explore unconventional methods and new ideas; and,

(3) gather and compile data so that teams can make valid interpretations in various environments and conditions of geology.

With this in mind, then, I would like to discuss the research program as we see it now.

As previously noted, the success of an inspection team will depend to a large extent on its ability to reduce the target area rapidly. In this effort, the team will probably be forced to rely heavily on aerial photographic techniques. In order to refine these techniques for use by inspection teams and to collect data, we have laid out a program which includes the following:

(1) Investigation of optimum camera-lens-film and filter combinations for varied terrain and weather conditions;

(2) Study of reflectance and other characteristics of damaged vegetation and detection of these effects by aerial photography and infra-red methods; and,

(3) Interpretation of aerial photography taken before and after test explosions to detail terrain effects and human activity connected with test shots.

Seismic noise monitoring, that is, listening for earthquake or explosion aftershocks, may provide a unique method to distinguish earthquakes from underground nuclear explosions. The data, at present however, are meager. We have initiated a program to collect aftershock data from the test explosions and from small earthquakes in the San Francisco Bay area. Three panel trucks have been equipped with strings of geophones and magnetic recording equipment. On short notice this gear can be moved to epicentral areas in Northern California to record aftershocks following Richter magnitude 4 to 5 earthquakes. In connection with these operations, terrain studies will be carried out to pinpoint possible surface effects. We are just now considering the possibility of extending aftershock studies to worldwide environments.

Seismic profiling is one of the few techniques that offer the possibility of direct cavity or crushed zone detection. We intend to explore the usefulness of present methods over existing cavities at the Nevada Test Site and at VELA research explosions. At present, however, it is difficult and time-consuming to cover large areas in the fine detail necessary for on-site inspection. We hope, in this connection, to initiate work directed toward development of continuous signal sources and wider coverage.

Magnetic and electromagnetic surveys, probably using airborne equipment, may prove useful in detecting drill hole casings or buried conductors, and we have started work to explore these methods at the forthcoming test explosions. We also want to investigate the usefulness of these techniques in areas with shallow water cover, for instance, the off-shore oil fields in the Gulf of Mexico.

Underground testing in such an area--that is an underground-underwater test--poses a special problem for inspection teams. Absence of surface features such as roads or evidence of human activity will make it difficult to reduce the target area to a size where geophysical techniques can be used efficiently. In this connection, we plan to investigate the usefulness of modern methods of marine acoustic or seismic surveying to detect crushed zones or possible bottom modification.

Theoretically, an underground nuclear explosion will cause surface motion, mainly vertical slumping over the cavity and chimney. The problem is to measure this motion as it occurs after the shot. Preliminary studies using liquid level methods have been carried out at past explosions and will likely be continued. Additionally, we intend to explore the application of photogrammetry to this problem at some of the future test explosions.

Inspection teams would probably make detailed radiation surveys even though it is unlikely that a well-planned test would vent to the surface. These techniques are standard and have been employed for a long time at the various underground tests. In addition, we are examining the usefulness of radon release measurements. Increased permeability of the soil resulting from the shockwave or gas pressure from the explosion will tend to increase ground radon releases. We have instituted a program to collect background data on radon equilibria and also to measure such increases as might occur after explosions and earthquakes.

Ground electrical surveys, as noted in the figure, are a possible technique for detection of crushed zones or cavities. We feel that present methods do not allow sufficient penetration to reach the depths at which well-contained tests would be conducted. Nevertheless, we hope to keep abreast of developments in this field and will try to utilize any major advances that are made.

Gravity surveys are in a similar category. Calculations indicate that cavities or crushed zones resulting from underground tests would cause gravity anomalies of about .001 to .01 milligals. These anomalies seem to be somewhat below the limit of present capability. As in the previous case, we hope to keep abreast of improvements in instrumentation.

The last method shown in the slide is somewhat specialized and applies only to tests that might be conducted in abandoned mines or abandoned drifts of active mines. The thought here is that during the period of abandonment an equilibrium is reached between the temperature of the mine wall and the air. Use of a mine drift for testing and necessary ventilation would upset this equilibrium. Sensitive temperature measurements therefore might indicate whether a supposedly abandoned mine had in fact been used.

In addition to the work directed toward these specific techniques, we are also undertaking a more general project to guide us in the research program. This work will evaluate the current level of capability in the various techniques, provide information on the direction of current research, and indicate how the various methods can best be adapted for use by inspection teams. By increasing contact with industrial and academic circles, we also hope that this project will help in developing completely new ideas and unconventional methods.

In summary, then, we have reviewed the criteria for inspection of events and their possible locations; the characteristics of clandestine tests that are of interest; inspection procedures; and, in general, the research we plan on the various techniques. I appreciate greatly the opportunity to present this material to you and certainly hope it will help stimulate active interest and participation of many of you in our program.

I

## CRITERIA FOR EVENTS ELIGIBLE FOR INSPECTION

**(as "tabled" in Geneva)**

1. **Magnitude 4.75 or greater**
2. **Approximate time and position established**

**EXCEPTIONS:**

*Events below 60 KM*
*Foreshocks or aftershocks*
*Deep ocean events with no consistent hydroacoustic signal*

**INSPECTION AREA**

**200 to 500 square kilometers**

Figure 1

## CLANDESTINE TEST CHARACTERISTICS OF SIGNIFICANCE TO ON-SITE INSPECTION RESEARCH

I. Site Preparation

1. Personnel
2. Tunneling or drilling equipment
3. Trucks, aircraft, ships

II. Instrumentation and Firing

1. Personnel
2. Instrument holes
3. Cable or telemetering equipment

III. Effects

1. Rubble-filled cavity plus chimney (70,000 cubic yards per KT)
2. Vegetation damage
3. Fracturing, faulting, venting

Figure 2

## POSSIBLE ON-SITE INSPECTION TECHNIQUES

| ON-SITE TECHNIQUES | "EFFECT" OR EVIDENCE |
|---|---|
| Photography | Human activity<br>Vegetation damage<br>Ground displacement |
| Infra-Red Surveys | Human activity<br>Vegetation damage |
| Seismic Noise Monitoring | Aftershocks or noises |
| Seismic Profiling | Crushed zone or cavity |
| Magnetic and Electromagnetic Surveys | Presence of metallic conductors or ferromagnetic objects on or in the earth |
| Acoustical Surveys (Marine) | Bottom modification<br>Crushed zone or cavity |
| Surface Subsidence Measurements | Post-shot subsidence over the cavity |
| Geochemistry | Anomalous radiochemistry |
| Ground Electrical Surveys | Dehydration |
| Gravity Surveys | Crushed zone or cavity |
| Mine Wall Temperature Variations | Human activity in abandoned mines |

Figure 3

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